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Yields of the Field Experiments 1994

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Rotations

Rothamsted Research

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94/W/RN/3

LEY/ARABLE

Object: To compare the effects on soil fertility of rotations with or without leys - Woburn, Stackyard D.

Sponsor: P.R. Poulton.

The 57th year, leys, w. beans, w. wheat, w. rye, s. barley.

For previous years see 'Details' 1967 & 1973 and 74-93/W/RN/3.

Design: 5 series of 8 plots, split for treatments other than rotations.

Whole plot dimensions: 8.53 x 40.7.

Treatments: All phases of four five-course rotations were originally present:

ROTATION

LEY	Clover/grass ley:	L, L, L, P, W
CLO	All legume ley:	SA, SA, SA, P, W until 1971 then CL, CL, CL, P, W
A	Arable with roots:	P, R, C, P, W until 1971 then P, B, B, P, W
A H	Arable with hay:	P, R, H, P, W until 1971 then P, B, H, P, W

P = potatoes, R = w. rye, C = carrots, W = w. wheat, B = s. barley,
H = hay, L = clover/grass ley, SA = sainfoin ley, CL = red clover ley

Rotations themselves followed different cycles:

On four plots in each block the rotations were repeated

On four plots in each block arable rotations alternated
each five years with ley rotations

From 1976 all the rotations were changed on all phases
except for the first and second test crops in 1976:

LN 3	(Previous LEY) LN, LN, LN, W, R
LC 3	(Previous CLO) LC, LC, LC, W, R
AF	(Previous A) F, F, BE, W, R
AB	(Previous A H) B, B, BE, W, R

LN1 to LN3 = three year grass ley with N, 1st year to 3rd year,
LC = clover/grass ley no N, BE = beans (s. oats until 1980), F = fallow

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Plots hitherto in alternating rotations were changed to test eight-year leys:

LLN	LN, LN, LN, LN, LN, LN, LN, LN, W, R
LLC	LC, LC, LC, LC, LC, LC, LC, LC, W, R

LLN1 to LLN8 = eight year grass ley with N, first year to eighth year, similarly for LLC

The new scheme started by sowing these new leys in spring 1976 on four phases and in spring 1977 on the fifth phase (2nd test crop in 1976).

In 1992 w. rye (R) replaced s. barley (B) as the second test crop.

Yields are taken only from the leys and the test crops.

Treatments to first test crop w. wheat, all combinations of:

Whole plots

1. ROTATION Rotations:

LN 8
LN 3
LC 8
LC 3
AF
AB

1/2 plots

2. FYMRES63 Farmyard manure residues, last applied 1963:

NONE	
FYM	38 tonnes on each occasion

1/8 plots

3. N Nitrogen fertilizer (kg N) as 'Nitro-Chalk':

0
70
140
210

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Treatments to second test crop w. rye, all combinations of:

Whole plots

1. **ROTATION** Rotations:

LN 8
LN 3
LC 8
LC 3
AF
AB

1/2 plots

2. **FYMRES62** Farmyard manure residues, last applied 1962:

NONE
FYM 38 tonnes on each occasion

1/8 plots

3. **N** Nitrogen fertilizer (kg N) as 'Nitro-Chalk':

0
30
60
90

Treatments to leys:

FYM RES Farmyard manure residues:

NONE
FYM 38 tonnes on each occasion, last applied 1966 to 1st
and 6th year leys, 1965 to 2nd and 7th year leys,
1964 to 3rd and 8th year leys, 1963 to 4th year leys,
1962 to 5th year leys

Corrective K dressings (kg K₂O) as muriate of potash, applied to first
test crop w. wheat and long-term leys in the wheat block, applied:
21 Oct, 1993:

Continuous rotations	No FYM half plots	FYM half plots
LN	0	0
LC	0	0
AF	315	280
AB	325	290

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Ex-alternating rotations

LN 8 ploughed for w. wheat	0	0
LN 8 not ploughed	0	0
LC 8 ploughed for w. wheat	0	0
LC 8 not ploughed	0	0

Experimental diary:

Treatment crops:

Grass ley and clover/grass ley, 1st year (**ROTATION** LN1, LC1, LLN1 and LLC1):

- 19-Aug-93 : T : Roundup at 5.33 l in 200 l.
- 10-Sep-93 : T : Ploughed.
- 17-Sep-93 : T : LN1 and LLN1 only: 27% N at 280 kg.
- : T : LC1 and LLC1 only: 27% N at 186 kg.
- 24-Sep-93 : T : Rotary harrowed.
- : T : LN1 and LLN1 only: 50% Bundy meadow fescue and 50% Erecta timothy mixture drilled at 30 kg.
- : T : LC1 and LLC1 only: 45% Bundy meadow fescue, 45% Erecta timothy and 10% Huia white clover mixture drilled at 30 kg.
- 18-Apr-94 : T : PK as (0:18:36) at 417 kg.
- : T : LN1 and LLN1 only: NK as (25:0:16) at 300 kg.
- : T : LC1 and LLC1 only: Muriate of potash at 80 kg.
- 08-Jun-94 : T : First cut.
- 10-Jun-94 : T : Produce removed.
- 14-Jun-94 : T : LN1 and LLN1 only: NK as (25:0:16) at 300 kg.
- : T : LC1 and LLC1 only: Muriate of potash at 80 kg.
- 15-Jun-94 : T : Chain harrowed.
- 02-Sep-94 : T : Second cut.
- 03-Oct-94 : T : Remainder of plot cut.
- 04 Oct-94 : T : Produce removed.

Grass leys, 2nd to 8th years (**ROTATION** LN2-3, LLN2-8):

- 21-Oct-93 : T : LLN5 only: Dolomite at 5.0 t.
- 18-Apr-94 : T : PK as (0:18:36) at 417 kg, NK as (25:0:16) at 300 kg.
- 08-Jun-94 : T : First cut.
- 10-Jun-94 : T : Produce removed.
- 14-Jun-94 : T : NK as (25:0:16) at 300 kg.
- 15-Jun-94 : T : Chain harrowed.
- 02-Sep-94 : T : Second cut.
- 03-Oct-94 : T : Remainder of plot cut.
- 04-Oct-94 : T : Produce removed.

Clover/grass leys, 2nd to 8th years (**ROTATION** LC2-3 and LLC2-8):

- 21-Oct-93 : T : LLC5 only: Dolomite at 5.0 t.
- 18-Apr-94 : T : PK as (0:18:36) at 417 kg, muriate of potash at 80 kg.
- 08-Jun-94 : T : First cut.
- 10-Jun-94 : T : Produce removed.
- 14-Jun-94 : T : Muriate of potash at 80 kg.
- 15-Jun-94 : T : Chain harrowed.
- 02-Sep-94 : T : Second cut.
- 03-Oct-94 : T : Remainder of plot cut.
- 04-Oct-94 : T : Produce removed.

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Experimental diary:

S. barley, 1st and 2nd treatment crops (**ROTATION AB**):

- 15-Mar-94 : T : Ploughed.
- 18-Mar-94 : T : NPK as (20:10:10) at 400 kg.
- 21-Mar-94 : T : Rotary harrowed, Alexis dressed Panoctine Plus drilled at 325 seeds per m².
- 19-May-94 : T : Vindex at 1.1 l with Duplosan New System CMPP at 2.0 l in 200 l.
- 12-Jun-94 : T : Radar at 0.5 l in 200 l.
- 21-Aug-94 : T : Combine harvested.

W. beans, 3rd treatment crop (**ROTATION AF and AB**):

- 19-Aug-93 : T : AB only: Roundup at 5.33 l in 200 l.
- 21-Oct-93 : T : PK as (0:24:24) at 168 kg. Punch broadcast at 24 seeds per m², ploughed.
- 10-Feb-94 : T : Carbetamex at 3.0 kg in 200 l.
- 09-May-94 : T : Rovral Flo at 1.5 l with Bravo at 1.0 l in 200 l.
- 12-Jun-94 : T : Rovral Flo at 1.5 l with Bravo at 1.0 l in 300 l.
- 19-Aug-94 : T : Combine harvested.

Fallow, 1st and 2nd treatment years (**ROTATION AF**):

- 19-Aug-93 : T : After rye only: Roundup at 5.33 l in 200 l.
- 10-Sep-93 : T : After rye only: Ploughed.
- 24-Sep-93 : T : After rye only: Rotary harrowed with crumbler attached.
- 19-Apr-94 : T : Heavy spring-tine cultivated.
- 27-Jun-94 : T : Rotary cultivated.

W. wheat, 1st test crop (W):

- 21-Oct-93 : T : Ploughed.
- 22-Oct-93 : T : PK as (0:24:24) at 260 kg. Yaltox at 150 kg. Rotary harrowed, Mercia, dressed Panoctine, drilled at 325 seeds per m².
- 19-Apr-94 : T : N 70, 140 and 210: Applied as 27% N.
- 01-May-94 : T : Oxytril CM at 1.5 l with Duplosan New System CMPP at 2.0 l and Halo at 1.5 l in 200 l.
- 30-May-93 : T : Cyclone at 1.0 l with Mistral at 0.5 l in 200 l.
- 14-Jun-94 : T : Hostathion at 0.84 l in 200 l.
- 15-Aug-94 : T : Combine harvested.

W. rye, 2nd test crop (R):

- 19-Aug-93 : T : Roundup at 5.33 l in 200 l.
- 21-Oct-93 : T : Dolomite at 5 t. Ploughed.
- 22-Oct-93 : T : PK as (0:24:24) at 260 kg. Yaltox at 150 kg. Rotary harrowed, Amando, dressed Baytan, drilled at 350 seeds per m².
- 20-Apr-94 : T : N 30, 60 and 90: Applied as 27% N.
- 01-May-94 : T : Vindex at 1.4 l with Starane 2 at 0.5 l and New 5C Cycocel at 2.5 l in 200 l.
- 29-May-94 : T : Radar at 0.5 l in 200 l.
- 09-Aug-94 : T : Combine harvested.

NOTE: Samples of grass, clover/grass, wheat and rye grain were taken for chemical analysis.

94/W/RN/3

LEYS

1ST CUTTING OCCASION (8/6/94) DRY MATTER TONNES/HECTARE

***** Tables of means *****

FYM RES	NONE	FYM	Mean
LEY			
LC1	1.85	2.75	2.30
LC2	4.33	4.28	4.30
LC3	4.34	5.34	4.84
LN1	4.67	4.45	4.56
LN2	6.04	6.08	6.06
LN3	5.97	6.09	6.03
LLC1	2.12	2.54	2.33
LLC2	5.17	5.18	5.17
LLC3	5.29	4.93	5.11
LLC4	5.40	4.96	5.18
LLC5	5.50	5.71	5.60
LLC6	4.47	4.67	4.57
LLC7	4.46	4.33	4.40
LLC8	3.46	4.15	3.81
LLN1	4.80	4.77	4.79
LLN2	6.31	6.15	6.23
LLN3	6.25	6.31	6.28
LLN4	5.77	6.60	6.19
LLN5	5.70	5.92	5.81
LLN6	3.24	4.51	3.88
LLN7	5.12	4.68	4.90
LLN8	5.24	5.30	5.27
Mean	4.80	4.99	4.89

1ST CUT MEAN DM% 20.6

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LEYS

2ND CUTTING OCCASION (2/9/94) DRY MATTER TONNES/HECTARE

***** Tables of means *****

FYM RES	NONE	FYM	Mean
LEY			
LC1	1.87	2.41	2.14
LC2	0.60	0.77	0.68
LC3	0.69	0.68	0.68
LN1	3.94	3.12	3.53
LN2	1.54	2.09	1.82
LN3	0.74	0.71	0.72
LLC1	2.24	1.90	2.07
LLC2	0.74	1.04	0.89
LLC3	0.57	0.60	0.58
LLC4	0.72	0.69	0.71
LLC5	1.11	1.09	1.10
LLC6	0.68	0.39	0.53
LLC7	0.37	0.62	0.49
LLC8	0.65	0.70	0.67
LLN1	3.65	3.88	3.76
LLN2	1.18	1.27	1.22
LLN3	0.82	0.95	0.88
LLN4	1.28	1.06	1.17
LLN5	1.41	1.54	1.47
LLN6	1.05	1.32	1.18
LLN7	0.84	0.79	0.81
LLN8	1.10	1.03	1.06
Mean	1.26	1.30	1.28

2ND CUT MEAN DM% 33.3

94/W/RN/3

LEYS

TOTAL OF 2 CUTTING OCCASIONS DRY MATTER TONNES/HECTARE

***** Tables of means *****

FYM RES	NONE	FYM	Mean
LEY			
LC1	3.73	5.16	4.44
LC2	4.92	5.05	4.99
LC3	5.03	6.02	5.53
LN1	8.61	7.56	8.09
LN2	7.58	8.17	7.88
LN3	6.71	6.80	6.76
LLC1	4.36	4.44	4.40
LLC2	5.91	6.21	6.06
LLC3	5.85	5.53	5.69
LLC4	6.12	5.65	5.88
LLC5	6.61	6.80	6.70
LLC6	5.15	5.06	5.10
LLC7	4.83	4.95	4.89
LLC8	4.11	4.85	4.48
LLN1	8.45	8.65	8.55
LLN2	7.48	7.42	7.45
LLN3	7.07	7.26	7.17
LLN4	7.05	7.66	7.35
LLN5	7.11	7.46	7.28
LLN6	4.29	5.83	5.06
LLN7	5.95	5.47	5.71
LLN8	6.34	6.33	6.34
Mean	6.06	6.29	6.17

TOTAL OF 2 CUTS MEAN DM% 26.9

PLOT AREA HARVESTED 0.00200

94/W/RN/3

W. WHEAT 1ST TEST CROP

GRAIN TONNES/HECTARE

***** Tables of means *****

FYMRES63	NONE	FYM	Mean
ROTATION			
LN 8	5.51	4.92	5.21
LN 3	5.93	5.62	5.78
LC 8	5.59	5.11	5.35
LC 3	5.56	5.74	5.65
AF	5.28	5.51	5.40
AB	2.54	3.11	2.82
Mean	5.07	5.00	5.03

N	0	70	140	210	Mean
ROTATION					
LN 8	3.31	4.68	6.36	6.51	5.21
LN 3	4.33	5.60	6.68	6.49	5.78
LC 8	3.15	5.89	5.52	6.84	5.35
LC 3	4.60	5.46	5.71	6.82	5.65
AF	1.63	4.83	7.35	7.77	5.40
AB	0.84	3.59	3.67	3.19	2.82
Mean	2.98	5.01	5.88	6.27	5.03

N	0	70	140	210	Mean
FYMRES63					
NONE	3.11	5.27	5.91	5.99	5.07
FYM	2.85	4.75	5.85	6.55	5.00
Mean	2.98	5.01	5.88	6.27	5.03

	N	0	70	140	210
ROTATION	FYMRES63				
LN 8	NONE	3.32	4.87	7.51	6.33
	FYM	3.30	4.48	5.21	6.69
LN 3	NONE	4.38	6.05	7.27	6.04
	FYM	4.28	5.15	6.09	6.95
LC 8	NONE	3.85	6.22	5.65	6.64
	FYM	2.45	5.56	5.38	7.05
LC 3	NONE	4.59	5.37	5.64	6.64
	FYM	4.62	5.54	5.77	7.00
AF	NONE	1.87	4.87	7.16	7.23
	FYM	1.39	4.79	7.53	8.31
AB	NONE	0.65	4.22	2.22	3.07
	FYM	1.04	2.95	5.12	3.32

GRAIN MEAN DM% 86.1

PLOT AREA HARVESTED 0.00201

94/W/RN/3

W. RYE 2ND TEST CROP

GRAIN TONNES/HECTARE

***** Tables of means *****

FYMRES62	NONE	FYM	Mean
ROTATION			
LN 8	5.84	5.94	5.89
LN 3	6.38	6.08	6.23
LC 8	5.95	6.04	5.99
LC 3	6.50	6.40	6.45
AF	3.83	3.76	3.80
AB	5.15	4.94	5.05
Mean	5.61	5.52	5.57

	N	0	30	60	90	Mean
ROTATION						
LN 8		3.52	5.53	6.73	7.77	5.89
LN 3		3.58	5.63	7.32	8.37	6.23
LC 8		3.56	5.08	7.37	7.96	5.99
LC 3		3.87	6.03	7.67	8.23	6.45
AF		1.23	2.99	4.82	6.14	3.80
AB		2.51	4.49	5.95	7.23	5.05
Mean		3.05	4.96	6.64	7.62	5.57

	N	0	30	60	90	Mean
FYMRES62						
NONE		3.08	4.95	6.69	7.71	5.61
FYM		3.01	4.97	6.60	7.52	5.52
Mean		3.05	4.96	6.64	7.62	5.57

		N	0	30	60	90
ROTATION	FYMRES62					
LN 8	NONE		3.51	5.28	6.51	8.07
	FYM		3.54	5.79	6.95	7.47
LN 3	NONE		3.30	5.99	7.63	8.59
	FYM		3.87	5.28	7.01	8.15
LC 8	NONE		3.46	5.13	7.28	7.91
	FYM		3.66	5.02	7.46	8.00
LC 3	NONE		4.21	6.13	7.39	8.29
	FYM		3.52	5.94	7.94	8.18
AF	NONE		1.41	2.72	5.35	5.87
	FYM		1.06	3.27	4.30	6.41
AB	NONE		2.61	4.48	5.95	7.55
	FYM		2.41	4.50	5.95	6.91

GRAIN MEAN DM% 86.1

PLOT AREA HARVESTED 0.00201

94/W/RN/12

ORGANIC MANURING

Object: To study, from crop yields and soil analyses, the effects of a range of types of organic matter - Woburn, Stackyard B.

Sponsor: P.R. Poulton.

The 30th year, w. wheat.

For previous years see 'Details' 1973 and 74-93/W/RN/12.

Design: 4 blocks of 8 plots split into 6 sub-plots.

Whole plot dimensions: 8.0 x 30.5.

Treatments: From 1966 to 1971 the experiment had a preliminary period designed to build up organic matter, derived from different sources. An arable rotation was started on two blocks in 1972 and the remaining two blocks in 1973. After a period of testing the residues built up, a further period of accumulation was started; on two blocks (which included ley sown in 1979) in 1981 and on the other two (which included ley sown in 1980) in 1982. On the first pair leys were ploughed for 1st test crop in 1987, on the second pair for 1st test crop in 1988.

Whole blocks

1. CROPSEQ

WHEAT 3	3rd wheat, after w. wheat 1988, potatoes 1989, w. wheat 1990, w. beans 1991
WHEAT 4	4th wheat, after w. wheat 1987, potatoes 1988, w. wheat 1989, w. beans 1990

Whole plots

2. TREATMNT Previous treatments:

LC 8 GM	Eight-year clover/grass ley until 1987 (WHEAT 3) or 1986 (WHEAT 4), green manure in the preliminary period
LC 8 PT	As above, peat in the preliminary period
LC 6 LC	Six-year clover/grass ley until 1987 (WHEAT 3) or 1986 (WHEAT 4), clover/grass ley in the preliminary period
LC 6 LN	As above, grass ley with N in the preliminary period
FYM	Farmyard manure annually 1981 to 1986 (WHEAT 3) or 1985 (WHEAT 4) and in the preliminary period
STRAW	Straw in both periods
FERT-FYM	Fertilizers only in both periods, rates of P, K & Mg equivalent to amounts in FYM
FERT-STR	Fertilizers only in both periods, rates of P, K & Mg equivalent to amounts in straw (+P)

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Sub-plots

3. **N** Nitrogen fertilizer in 1994 (kg N) as 'Nitro-Chalk':

0
50
100
150
200
250

Experimental diary:

10-Sep-93 : B : Ploughed.
16-Oct-93 : B : Rotary harrowed, Mercia, dressed Panocrine, drilled at
 325 seeds per m².
11-Apr-94 : T : N 50, 100, 150, 200, 250: Applied as 27% N.
01-May-94 : B : Oxytril CM at 1.5 l with Duplosan New System CMPP at
 2.0 l and Halo at 1.5 l in 200 l.
24-May-94 : B : Vytel Liquid Chelated Manganese (chelated Mn as Mn EDTA
 in solution equivalent to 6.4% w/v Mn) at 1.5 l in
 200 l.
30-May-94 : B : Cyclone at 1.0 l with Mistral at 0.5 l in 200 l.
14-Jun-94 : B : Hostathion at 0.84 l in 200 l.
21-Aug-94 : T : CROPSEQ WHEAT 4: Combine harvested.
22-Aug-94 : T : CROPSEQ WHEAT 3: Combine harvested.

NOTE: Straw yields were recorded on the CROPSEQ WHEAT 4 plots. Grain and straw samples were taken for chemical analysis.

94/W/RN/12

CROPSEQ WHEAT 3

GRAIN TONNES/HECTARE

***** Tables of means *****

	N	0	50	100	150	200	250	Mean
TREATMNT								
LC 8 GM		0.56	1.89	3.00	3.30	4.60	3.99	2.89
LC 8 PT		0.78	2.09	3.50	3.86	4.70	3.99	3.15
LC 6 LC		0.76	2.02	3.57	4.41	4.16	4.76	3.28
LC 6 LN		0.83	2.27	4.14	4.49	4.06	4.19	3.33
FYM		1.23	2.92	4.24	5.69	5.38	4.71	4.03
STRAW		0.46	1.87	3.99	5.26	5.31	5.85	3.79
FERT-FYM		0.53	2.14	4.22	4.52	4.54	5.05	3.50
FERT-STR		0.53	2.37	3.41	4.10	4.63	4.60	3.28
Mean		0.71	2.20	3.76	4.45	4.67	4.64	3.41

*** Standard errors of differences of means ***

TREATMNT	N	TREATMNT
		N
	0.471	0.249
		0.797
Except when comparing means with the same level(s) of		
TREATMNT		0.704

***** Stratum standard errors and coefficients of variation *****

Stratum	d.f.	s.e.	cv%
BLOCK.WP	7	0.471	13.8
BLOCK.WP.SP	40	0.704	20.7

GRAIN MEAN DM% 86.8

94/W/RN/12

CROPSEQ WHEAT 4

GRAIN TONNES/HECTARE

***** Tables of means *****

	N	0	50	100	150	200	250	Mean
TREATMNT								
LC 8 GM	1.25	3.49	5.75	6.53	6.52	6.51	5.01	
LC 8 PT	1.03	3.19	5.45	6.17	6.55	6.51	4.81	
LC 6 LC	1.40	3.20	5.57	7.17	6.67	6.12	5.02	
LC 6 LN	1.55	3.84	6.20	6.52	7.52	7.27	5.48	
FYM	1.65	3.28	5.22	5.93	5.63	6.27	4.66	
STRAW	1.00	2.67	5.18	5.72	6.30	6.09	4.49	
FERT-FYM	0.80	3.15	5.43	5.34	6.03	5.66	4.40	
FERT-STR	0.55	2.45	4.39	5.09	5.34	5.93	3.96	
Mean	1.16	3.16	5.40	6.06	6.32	6.30	4.73	

*** Standard errors of differences of means ***

TREATMNT	N	TREATMNT
		N
0.489	0.206	0.723
Except when comparing means with the same level(s) of		
TREATMNT		0.584

***** Stratum standard errors and coefficients of variation *****

Stratum	d.f.	s.e.	cv%
BLOCK.WP	7	0.489	10.3
BLOCK.WP.SP	40	0.584	12.3

GRAIN MEAN DM% 86.1

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CROPSEQ WHEAT 4

STRAW TONNES/HECTARE

***** Tables of means *****

N	0	50	100	150	200	250	Mean
TREATMNT							
LC 8 GM	0.47	1.73	3.10	4.25	4.21	4.39	3.03
LC 8 PT	0.44	1.86	3.20	4.01	4.32	4.30	3.02
LC 6 LC	0.73	1.38	2.86	4.28	3.78	3.52	2.76
LC 6 LN	0.73	2.34	3.85	3.75	4.98	5.58	3.54
FYM	0.65	2.02	3.22	3.96	3.68	4.37	2.98
STRAW	0.41	1.36	2.93	3.39	3.35	4.18	2.60
FERT-FYM	0.47	1.82	2.93	2.80	3.55	3.57	2.52
FERT-STR	0.10	1.51	2.61	2.54	3.12	3.66	2.26
Mean	0.50	1.75	3.09	3.62	3.87	4.20	2.84

STRAW MEAN DM% 89.5

SUB PLOT AREA HARVESTED 0.00202